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interior of Australia, in a north-westerly direction from Spencer Gulf, a large extent of well-watered country.

With regard to the rounded hillocks which Mr. Stuart discovered, he believed they were of volcanic origin, an offshoot of the great volcanic band which ran through the whole of the Indian Archipelago. Then, as to the existence of gold, he had much confidence that that would turn out to be a solid discovery. There was certainly gold in South Australia, as well as in Victoria. He brought home some specimens in 1841, and, reasoning from analogy, he thought it likely gold would be found stretching across the Australian continent to the Indian Archipelago, just as it had been discovered stretching along the whole length of the American continent. Therefore, he saw every reason to think well of the prospects of that portion of Australia, and he hoped it would not be long before telegraphic communication was established between the south-eastern colonies and the mother country by the line of the north-western coast, Java and Singapore.

The second Paper read was—

2. *Discovery of a New Harbour on the North-East Coast of Australia.*

Communicated by SIR G. F. BOWEN, F.R.G.S., Governor of Queensland, through the DUKE of NEWCASTLE, F.R.G.S.

A NEW and capacious harbour is stated to have been discovered in the new colony of Queensland, North-Eastern Australia, to the north of the FitzRoy. The party who made the discovery consisted of Captain Sinclair (the master of a little schooner of nine tons), accompanied by one seaman and two passengers. His exploratory cruise was planned mainly in the hope that a reward would be given for the discovery of a secure harbour north of Port Curtis.

Captain Sinclair started from Rockhampton in September, 1859, and followed the shore, anchoring each night and being continually pestered by the natives. On October 14th he had arrived at Gloster Island; the next day he sailed close up to Mount Edgcumbe, and anchored for the night in a sheltered bay. The subsequent night he anchored inside an island, and when the morning broke found, to his astonishment, that the schooner was lying in a fine capacious harbour, sheltered from all winds. Within a cable-length of shore there is from 3 to 4 fathoms; in the middle of the bay, from 7 to 10. There is plenty of fresh water. The harbour is formed partly by islands and partly by sand-banks. One of the islands was between 5 and 6 miles in circumference. Beyond these facts no data of any sort have yet reached this Society. The harbour was named Port Denison.

The CHAIRMAN said he saw present an old friend of his, Mr. J. Beete Jukes, a distinguished geologist and traveller. Mr. Jukes took part in the survey made during some years by one of Her Majesty's ships round the coasts of Australia, and particularly examined the coral islands stretching away from

Cape York to the great Barrier Reef. Though the ship to which he was attached missed this particular port, yet he could give them as much information respecting the physical geography of the coast as any person present. He therefore hoped Mr. Jukes would state what facts he knew, and at the same time communicate some of the knowledge he possessed respecting the formation of these remarkable coral reefs.

MR. J. BEETE JUKES said that he had been on board H.M.S. *Fly*, under the late Captain Blackwood, when the outer edge of a large part of the Barrier Reef, that great coral reef which ran along the north-east coast of Australia, was being surveyed. The survey was conducted by officers specially appointed for that service, marine surveyors, officers of the *Fly*, one of whom, his friend Mr. Evans, was present, and who, he must add, was the very person to whom the accuracy of the survey of the Barrier Reef was chiefly due. Mr. Evans had recalled to his recollection several facts connected with the particular part of the coast in which this harbour occurred, which, perhaps, the meeting would allow him to mention. It was a very interesting spot for a good harbour. There were already one or two harbours in that immediate neighbourhood. One called Port Mole was known long ago, and was discovered, he believed, by Flinders in the first instance. H.M.S. *Fly* lay in it for several days, while Captain Blackwood and some of the officers explored the neighbourhood in boats. He generally accompanied one or other of the boats. So far as he could make out, this particular harbour was in a bight of the coast which the boats did not happen to visit; therefore they were not lucky enough to discover it. They did, however, find several other indentations in the coast, just south of Port Mole, which were tidal harbours. There was one fact which made the situation of this harbour exceedingly important, not mentioned in the paper: it was this, that the rise of tide upon just that portion of the coast was much greater than upon any other part of the eastern coast of Australia. The rise and fall of tide amounted in some places to as much as 30 feet—vertical rise and fall; while in scarcely any other part was the rise and fall more than 6, 8, or 10 feet, at the outside. This, it would be seen, was a very important fact in connection with harbours, because the rise and fall of tide would facilitate all kinds of operations connected with the building and repairing of ships. That point was sufficiently obvious. It was also important in connection with another curious fact—that this was, he believed, the only part of the coast, certainly the only part of the north-eastern coast, where there was good ship timber. The timber of Australia in general sunk when it was put into the water; it was too heavy and too brittle, for the most part, for shipbuilding. Just in that particular part of the coast from Port Bowen northwards up to Cape Upstart, there were large forests of pine, a species of araucaria called Cuninghamii, a species of the same genus that the Norfolk Island pine belonged to; and so far as he could judge, it was a very good ship timber. Some parts of the *Fly* were repaired from this timber. These two facts, taken in connection, made the existence of a good land-locked harbour there exceedingly important. When they were there, it struck them that that particular part of the coast, between Broad Sound and Cape Upstart, was by far the best bit of coast they had seen anywhere round the whole circumference of Australia. Mr. Evans had also recalled to his recollection that in the account of the voyage of H.M.S. *Fly*, which was published in 1847, this fact was noted: that after going twice round the whole of Australia, and visiting parts of the coast on every side, they came to this conclusion, that this was the very best bit of land anywhere to be found so near the margin of the sea. Of course they could only judge from what they were able to see of some two or three miles inland. All the country round about Port Bowen and Port Curtis was exceedingly barren and rocky in comparison with the country he was speaking of. Farther north there seemed to be a considerable stretch of comparatively fertile land along the coast. The hills themselves, instead of

being barren and rising abruptly from the sea, as was generally the case along the north-east coast, were at a distance of 30 or 40 miles inland. All along the north-east coast there was a succession of north and south ranges, which came out and ended on the north-east coasts with bights behind the termination of each headland; and the recess north of Broad Sound, between the hills terminating there and the next ranges which came out about Rockingham Bay, seemed wider than usual, and with more low land.

The Chairman had asked him to say something about the coral reefs. In obedience to that request he would endeavour to give a brief description. Starting from Sandy Cape, near Harvey Bay, the north-east coast ran up to Cape York, which was the extreme northern point of the continent of Australia on that side, south of Torres Straits. A little north of Harvey Bay there appeared a set of coral islands and coral reefs, and from there the whole coast was fronted with a continuous margin of coral reefs, stretching right along the face of the coast, and across Torres Straits close up to the shore of New Guinea. The distance was not less than 1200 miles in a straight line. Now, if you were to translate that reef into this part of the world, and supposing it started from the north-west coast of France, it would encircle the British islands, including Ireland, the Orkneys and the Shetland isles, and stretch away up to Drontheim on the coast of Norway. This would give some idea of the extent of this coral reef. Imagine, then, a great submarine wall rising from an unknown depth in the bottom of the ocean just up to the level of low water—not one continuous wall, because it was broken through in the upper portion by a number of tolerably deep passages, perhaps twenty or thirty fathoms in depth. These would be like embrasures in the top of a fortress. But below that depth there would be one continued mass of coral matter. This matter was carbonate of lime—solid rock, the same substance as marble—secreted from its solution in the waters of the sea, and made to enter into the solid parts of the structure of the minute polyps that formed these corals. Having thus assumed a solid form, some of it was triturated after the death of the corals by the action of the sea, and spread over and among the unbroken corals, and all compacted together into a hard mass. The finer particles were even carried out and strewn all over the bed of the surrounding ocean, so that in every case in the neighbourhood, even as far as Singapore and Java, whenever he had examined the bottom that was brought up on the lead, he found it altogether soluble in dilute acid. There was in that sea a great limestone formation, a great calcareous deposit going on, the result of the action of these little animals, at the present time, similar to the older great masses of calcareous matter, such as the chalk which stretched all over the south-east coast of England, and over a large part of Europe. These little animals had added to the bulk of the earthy mass of Australia a great slice of country, which was at present only comparatively a little underneath the sea, 1200 miles long, varying from 10 to 90 miles in width; having, in fact, an average of 30 miles in width, and making, if lifted up above the surface, a very large tract of country, a great table-land, appended to the submarine slope of that side of Australia. The depth from which this wall rose up on its outer edge was certainly not less than 2000 feet. They sounded in some places close up to the reef, sometimes within the general direction of the outer edge; for there were great convolutions in the line of the reef, great bays in it; and they sounded in these bays and found no bottom at a depth of 1800 feet. They never reached bottom with any line that was ever put down, except close alongside the reef, within a very few yards where the water broke upon the ridge. So they might certainly assume that the height of this submarine wall was 2000 feet for a great part of its course. This was simply a description of fact. But there was something still more remarkable, perhaps, to be said in connection with this coral mass than the fact that the whole of this huge bulk of matter was solidified by the action of animals

of a very low grade indeed; and that was this—that none of these animals could live at a greater depth than some fifteen fathoms. They never could have formed the huge bulk of matter which entered into some of those very large corals, some of them as big as the platform upon which he was standing, and rising to such a height that several persons could land upon one of them, and walk about without being in sight of those on the other side of the mass. All the animals that made these great reef-forming corals were confined, when alive, to the comparatively slight depth of fifteen fathoms. How came it, then, that these coral reefs could spring from so great a depth as 2000 feet? Simply in this way; that when the commencement of the reef took place, the bottom of the sea, which was now 2000 feet under water, was within the depth of fifteen fathoms; and that since then the land had been slowly subsiding and settling downwards so gradually that these little animals continued to live and flourish upon the upper and outer margin of the reef, while the waste and débris derived from them added to the mass; and thus the upper surface of the reef was kept up in this comparatively shallow stratum of water just below the level of low tide, while the bottom of it was slowly and gradually sinking down. So that the existence of these coral reefs along the north-east coast of Australia, and over a large part of the neighbouring seas, was one of the proofs we had of the depression of a large portion of the country. Australia, large as it is, was formerly, perhaps, even larger, extending at all events so much farther out on the eastern coast as would be represented by a width of from 10 to 90 miles. Just upon the margin of the then sea, these creatures began to settle and to build; and, since then, as the country sank and the sea came farther and farther in upon the sloping land, the coral reef increased and increased, so as to keep it up to the dead level of low water.

He need not enter at any greater length into the consideration of this wonderful physical phenomenon; but if they would allow him to occupy the attention of the meeting for a few moments longer, he would say a word or two upon the subject of the first Paper, which was so intimately connected with the southern part of Australia. His reason for doing so was this, that a good many years ago he committed himself by printing and publishing a sketch upon the physical structure of Australia. This sketch was founded upon his own observations—upon observations made in H. M. S. *Fly* during a period of nearly four years that was passed on the coasts—as well as upon the observations that had, previously to 1847, been published on the subject. He had also had the advantage of meeting Captain Sturt upon his return from his great and truly adventurous journey into the interior of the country in the year 1846, and of discussing this point with him. The structure of the country, so far as he knew it, was this: There was a great continuous chain of mountains running along the eastern coast from Bass's Straits to Torres Straits. This eastern coast range was the principal range of the country. It was the one in which there were the highest mountains, namely, the Australian Alps, and it was the one which was the longest range, and which retained a continuous height for the greatest extent. It extended along the whole of the eastern coast, its crests being at a little distance in the interior. In the Melbourne country the ranges of mountains, short as they might be, all run north and south; and that was the case also with the ranges in South Australia, as Colonel Gawler well knew. It was the case certainly with the Darling range in Western Australia, where all the hills run north and south. They did not know of any east or west range in Australia, unless it were that high land which Leichhardt reached in the northern part of the country, which seemed to stretch from Cambridge Gulf, and to sink gradually down to the southern part of the Gulf of Carpentaria. That being the disposition of the high lands, let them look for a moment at the direction of the prevailing winds. During the greater part of the year —certainly during all the part that we called summer in England—in the northern part of Australia, lying within the tropics, or north of about 25° s.

lat., the only wind was the south-east trade-wind. This wind was always blowing from the south-east or from the east-south-east; while at the same time a strong, fierce westerly wind, generally south-westerly, though sometimes north-westerly, was blowing along the southern part of the country. Up to about 30° lay within the region of the westerly wind. The intermediate tract between 30° and 25° was subject to variable winds, according to the season. In our winter, viz., in the December part of the year, there was a north-west monsoon blowing upon the north-west coast. He believed he might say without contradiction, that within the tropics invariably low land was desert unless there were some lofty ranges of mountains in the neighbourhood, so that rivers could flow from them into the low land. He believed this was the case without exception in every part of the world. It certainly was the case with regard to the northern part of Australia during one six months of the year at all events. The only high land was directly upon the eastern coast; the consequence was that the easterly wind striking upon that was drained at once of all the moisture that the high land could extract from it. The wind had to climb over that high land to get into a comparatively cold region up above: that cold condensed the moisture, and the current of air was drained of as much of its moisture as could be got out of it at that altitude. After it had passed over that range it met with no other high land whatever, for, so far as we knew, the generality of the country was low. Even that high country south of Port Essington, according to Leichhardt, was not so high as the eastern coast. Therefore there could be no precipitation during all that part of the year, at all events during the prevalence of this easterly wind; on the contrary, this low land, being heated by the burning rays of the sun, caused the air to expand, and therefore made it rise, and put it into a state to lick up any moisture that there might be, rather than to deposit it. There was constantly a current of air rising up from this northern half of Australia, and taking up any moisture that presented itself; and it did not impinge upon the Indian Ocean again until it got 150 miles out into the sea. At least they found it so in the *Fly*. Now, during all this time, and during the rest of the year, the westerly wind was blowing along the south coast where there were these broken ranges—these comparatively short ranges of mountains that he spoke of—and the southern part of the eastern coast range. What did they find? On the west side of each of the ranges you found a fertile country. There was a comparatively fertile country on the strip of low land lying west of the Darling range. It was a grassy and woody country, and precipitation of moisture frequently occurred; but on the east side of that range you got a desert, a sandy plain, which no one had ever succeeded in getting across. Then you came to that great tract of low country which Mr. Eyre attempted to cross, where he had to carry water with him for several days at a time, for he found no river running out towards the coast, and could only get water trickling at certain spots from the cliffs of the sea-shore. But when you crossed this flat, and approached the ranges of South Australia, you expected a precipitation of water from the westerly wind. And there you found it. Mr. Stuart stated that he had found a tolerably well-watered country just where it was to be expected. But observe that when you once passed over these north and south ranges of South Australia, and got on their eastern side, you again came upon a desert—that very desert country through which the Darling river occasionally ran, but where the rivers were mostly all dried up, often forming merely a succession of water-holes. Crossing these great flat plains, which were more or less desert, you at last struck on the eastern coast-range, and again got into a well-watered country, where you found the Murray and other rivers.

It followed from all this that he was compelled rather to differ in opinion from Colonel Gawler on one point. Taking for granted that Colonel Gawler's idea of the structure of the country—that the high land was ranged

round the coast, and that the interior was a great hollow—taking that to be the true description, he was afraid that the hollow, although there would be plenty of space in it for water, would not have any water in it. He was afraid that the very fact of its being low land would be a total bar to any moisture ever getting into it, and that all the drainage that poured down in that direction from the surrounding high lands would be licked up long before it got into the interior. The only chance was, that there should be some range of very lofty land running into the interior, and that during winter, or in December, the north-west monsoon, which was greatly laden with moisture, should blow well into it, and should throw down such a quantity of moisture as would fertilise some considerable tracts for the remainder of the year. The time when the north-west monsoon blew was the only time when it rained at Port Essington: during all the rest of the year they never had a shower. About November and December, and from thence on to March, when the north-west wind was blowing, they had thunder-showers almost every day, and a large deposit of moisture.

COLONEL GAWLER responded that, in saying that he believed the centre of Australia to be a great crater, he did not mean anything like a volcanic crater, but that there was simply an outer range of hills, with a drainage into this centre. Nor did he mean to say that there might not be considerable ranges in the crater. It appeared to him absolutely necessary that there should be, for he quite agreed with Mr. Jukes, that there could not be a running water without elevations. The facts which Mr. Stuart had elicited proved that there must be ranges; for in penetrating to a distance of nearly 500 miles from the head of Spencer Gulf, he (Mr. Stuart) declared that he never was in want of water. He also describes a broad river flowing towards the east.

MR. J. S. WILSON said, he had been exploring the north-west part of Australia. One great feature of Australia was, that it was a great table-land, with the exception of a few primary ranges of hills which protruded about it. Another great feature was, that at one time it was so depressed that the sea beat into that table-land. The table-land consisted of sandstone on the surface and shale underneath. All the valleys had been cut out by the action of the sea, and where the sandstone had by this means been removed, leaving the shaly strata uncovered, the latter by its decomposition became a good soil. But it did not follow that there was also a productive country, for rain was required to nourish vegetation. Now, on the north-west coast, rains fell during the north-west monsoon, and probably that part of the country was as well watered as any part of Australia. The slope of the country might throw considerable quantities of water towards the interior, and consequently there might be rivers striking down towards the central depression. It would, therefore, appear that the best season to pass along the country was during the prevalency of the north-west monsoon, which was just the opposite season to the wet season of South Australia. It was during the season of the north-west monsoon that the hot winds of Southern and South-Eastern Australia prevailed, and he believed the latter to be the extension of the former, which expended its moisture and became heated in crossing the continent. With respect to the probability of finding gold in that part of the country, he was of a different opinion. The quartz which had been found there was a silicious sandstone, very like quartz in appearance, only it was not of the same geological age, gold-bearing quartz being a vein-stone filling rents in the primary slate rocks, but the quartz of the Burra Range, and all other ranges of the interior, is a horizontal rock of the carboniferous period, and extends over very large areas.

MR. J. CRAWFURD, F.R.G.S., said, if the soil on the north-east coast were good, there was ample room for a profitable colony. Mr. Jukes showed clearly that it was a well-watered country, and wherever within the tropics there was a well-watered country, there was sure to be fertility. He had no doubt there

was abundance of good land extending from the 29th degree, the southern boundary of the new Queensland, up to the 15th or the 16th degree. Beyond that we did not expect much good land. God protect them from going to the Gulf of Carpentaria, although eulogised by some of our Fellows! We had tried it and found it wanting, but for the rest he had no doubt it would be an excellent place for all tropical products, such as the sugar-cane, the coffee plant, and, best of all things, cotton; and, moreover, they could obtain plenty of labour from the Chinese, whose industry was proverbial, and who would labour in any climates from the Equator to the 50° of latitude.

SIR E. T. BELCHER, R.N., F.R.G.S., was delighted to hear that Professor Jukes had found out that these coral islands did not exactly spring from the bottom. He had studied the subject himself with great attention for many years. He was instructed, when commanding H.M.S. *Sulphur*, in the Pacific, to bore through one of these coral islands, and endeavour to determine whether it was based on the lips of a submerged volcano. Selecting Bow Island, he cut about 9 feet through the coral, and he then came to mud, a kind of pipe-clay. He continued cutting down until he reached 46 feet: there it was found so fluid that it was pumped out with a ship's engine! He afterwards carried out a line of soundings from Bow Island entrance, beginning at 3 fathoms and going down to 1600 and odd fathoms (9600 feet). He found the coral terminated abruptly at about 900 fathoms, all beyond that depth being sandy coralline débris. Mr. Jukes had not exactly explained the constitution of the coral that is between living corallines and coral rock, or the component parts of the solid coral which he had found. All recent corallines had very porous cells, but none of the solid coral exhibited any trace of porosity. It was formed apparently of the very fine *débris* agglutinated together, and it came to us pretty nearly in the same condition as the fossil corallines, with a surface which was capable of high polish. He believed Mr. Jukes was also quite right as to the depression of the coral, but he did not believe that the main land had ever shrunk an inch. He formed that opinion in 1825, after three years' constant examination of the Bermuda Reefs. When he went out in 1825, in H.M.S. *Blossom*, he examined the Dolphin Reef, on which the *Dolphin* struck when the island was first discovered. He made a very minute survey of it, because he then had an opinion that the *coral reefs* never *rose* from *below*. He did not find a living coralline on the reef, nor were any found at Loo Choo, of which Basil Hall gave such a glowing description. At that time the coral barrier round the island of Tahiti was so high that the *Blossom*, drawing but 16 feet, could only be forced into the harbour of Oututu Tuane *by hand* through a side opening in the barrier, and a boat could scarcely pass to Papite. But when he returned to the same place, in 1840, in H.M.S. *Sulphur*, the *Artemise, a sixty-gun frigate*, had passed freely through the same opening on to Papite; and a tree beside the spot where the Consul's house formerly stood, and to which the *Blossom's* cable was shackled, had *three fathoms of water under it:* consequently the whole of the coralline had been worn away, or possibly gone down, but the main land had not altered in the least. The American Expedition left a datum mark on Point Venus, so that the fact may be determined. To return to Bow Island: he examined and sounded it originally in 1825, with a thorough conviction that some day or other it would be his lot to return to the Pacific; and when he was instructed to make the borings alluded to, he fixed upon that island, having made such minute observations upon it in the first instance. There was one little islet within the lagoon on which he was accustomed to bleach his corals; that islet had disappeared altogether, and was not to be found in the new survey! When he first went there the whole island was belted with a continuous line of cocoa-nut trees; but at his last visit, after 15 years' interval, a small boat might have passed through some of the worn coralline channels. His belief was this: that these corallines were constantly working upon the edge of these lands;

that the sea was breaking them, and rubbing them down by attrition; that they slipped down gradually till they reached a certain depth, and formed a coral facing much in the manner that glaciers are formed; and that it was upon this new coating that these small animals formed, and upon which the others kept growing. He also disagreed from Mr. Jukes on another point, for he had brought up living corallines (massive coral) from the depth of 33 fathoms, and he once brought up a living coralline, a tree on a strombus, from a shoal at 156 fathoms; both strombus and coral were living. At Bow Island he had occasion to construct a pier. The coralline circles resting upon the fine sand, about 6 to 9 feet in diameter, were taken up, not having any attachment, and were wheeled, to the amusement of the crew, into the places assigned for them. I do not think any measured more than a foot in depth.

MR. JUKES said that you might bring up from 100 fathoms living corallines, but he expressly guarded himself from saying that all coral-making polyps lived only in shallow water. He said it was only the polyps that made these huge corals that lived within a comparatively short distance of the surface. Of course there were corallines that lived at a greater depth—at any depth in which life could at all exist. With respect to the theory of the formation of coral reefs which the gallant officer seemed to attribute to him, he had learnt it entirely from Mr. Darwin's book.

The CHAIRMAN, in closing the discussion, said that he had derived much information from Colonel Gawler, and he was certain they would thank him for having called upon his geological friend Mr. Jukes. The remarks he had made showed how intimately geology was connected with those great problems of physical geography which Mr. Jukes had so admirably depicted. In short, he (the Chairman) was quite proud of his geological associate, who had clearly shown why a large mass of the interior of Australia must be a waterless desert.

Ninth Meeting, March 26th, 1860.

SIR RODERICK I. MURCHISON, VICE-PRESIDENT, in the Chair.

PRESENTATIONS.—*Consul D. B. Robertson; Captain A. E. Wilkinson; and J. A. Dickinson; W. H. T. Huskisson; Samuel Kinns*, PH. DR.; *Daniel Meinetzhagen; and J. P. Stocker, Esqrs., were presented upon their Election.*

ELECTIONS.—*Colonel the Hon. Arthur Egerton; Major George Wilcock; and Roger Cunliffe; Bernard Dietz; T. M. Mackay; Alexander Mitchell; R. M. Montgomery; H. W. Peek; and David Walker, Esqrs., were elected Fellows.*

EXHIBITIONS.—Captain Berger's patent Sphereometer, invented for the purpose of obviating abstruse calculations in Navigation, and for facilitating passages, was exhibited at the meeting.

Among the donations to the Library and Map-Rooms since the former meeting were "Cycle of Celestial Objects," continued at the Hartwell Observatory to 1859, by Admiral W. H. Smyth, presented by the author and Dr. Lee; Swedish Government charts, presented